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TAGS: TRGY ENRG KSCA KNNP KS
SUBJECT: KOREA UNVEILS ADVANCED TOKAMAK FUSION TEST DEVICE BUILT WITH U.S. COLLABORATION

SUMMARY

¶1. On September 14, President Roh unveiled Korea's cutting-edge nuclear fusion plasma chamber, the Korea Superconducting Tokamak Advanced Research (KSTAR) device, at the National Fusion Research Center outside Daejeon. Built at a cost of some USD 329 million, KSTAR is one of the world's most advanced Tokamaks, using superconducting coils and advanced techniques to heat and shape plasma. KSTAR was built using domestic technology, with technical assistance from a number of fusion research labs in the United States and other countries. Following testing of its subsystems, KSTAR is expected to produce its first plasma by June 2008, and to achieve full-scale operations several years later. KSTAR will play an important role in international fusion research, both before and after the start-up of the larger-scale International Thermonuclear Experimental Reactor (ITER) in Cadarache, France, in 2016. Comment: KSTAR demonstrates both how far Korean science has progressed and the extent to which U.S.-Korean scientific collaboration continues to play a role in that progress. End summary.

KSTAR - CENTERPIECE OF KOREAN FUSION RESEARCH

¶2. The KSTAR Tokamak is the centerpiece of Korea's fusion research program. (Tokamak is a Russian acronym for Toroidal -- or doughnut-shaped -- Chamber in Magnetic Coils. It is a device using powerful magnets to confine a plasma -- ionized gases -- to permit controlled fusion reactions.) The Korean government has spent USD 329 million since 1995 to construct KSTAR and related devices at the NFRC, located in Daedeok Innopolis, outside of Daejeon (150 kilometers south of Seoul). A ceremony was held on September 14 to mark the completion of construction.

¶3. Lee Gyeong-su, Director of Fusion Research at Korea's National Fusion Research Center (NFRC), told ESTH that NFRC is still testing

individual KSTAR systems, and that full-scale operation is planned to begin by June, 2008. Once KSTAR is operational, Korea plans to spend some USD 37 million annually over eighteen years on fusion research. The goal is to maintain dense, superheated plasmas for periods of at least 300 seconds, in order to gather information on heating, diagnostic and controlling techniques. This information will feed into the multinational ITER project, in which Korea is a founding partner.

¶4. Looking further into the future, Korea's "road map" for fusion energy development aims to demonstrate the feasibility of fusion power generation by 2030; complete the engineering design of a fusion reactor by 2035; and begin commercial production of electricity using fusion by 2040.

¶5. As testament to the importance that the Korean government gives to the prospect of fusion energy, President Roh Moo-hyun attended the September 14 event, and spoke not once but three times. He lauded the scientists and domestic industries responsible for bringing the project to completion, and expressed his hope that KSTAR would play a crucial role in allowing Korea to achieve energy self-reliance. (Comment: With an election coming up, Roh also used the occasion to announce that he would seek legislative approval to bring scientists from NFRC and other state-run research institutes into the government pension scheme, a proposal that provoked smiles of approval among those assembled. End comment.)

COMPARING KSTAR TO EXISTING TOKAMAKS

¶6. NFRC says that KSTAR is the world's first Tokamak to use highly-efficient niobium-three-tin (Nb3Sn) coils to generate magnetic fields. The principal parameters of the KSTAR Tokamak are: major radius 1.8 meters, minor radius 0.5 meters, toroidal field 3.5 Telsa, plasma current 2.0 MA, plasma temperature range 100-300

million degrees Celsius, and magnet weight 270 tons.

¶7. George McKee, a University of Wisconsin fusion scientist who provided technical assistance for KSTAR and who attended the September 14 ceremony, provided ESTH with his assessment of how KSTAR compares to existing Tokamaks:

"KSTAR is a medium-sized Tokamak experiment. Currently, there are two larger experiments in the world (JT-60U in Japan and JET in Europe), and two comparably-sized experiments (DIII-D in the United States, and ASDEX-U in Germany). But KSTAR will be unique in that it employs fully superconducting magnets and implements the latest ideas and designs for obtaining the highest performing plasmas (so-called "Advanced Tokamak" plasmas). The EAST Tokamak that has just begun operations in Hefei, China, has roughly similar parameters to KSTAR and is also superconducting. However, KSTAR employs advanced plasma heating, shaping and current-drive capabilities, is somewhat larger, and has advanced control systems and a diagnostics suite. The two experiments should complement each other quite well."

PREPARING THE WAY FOR ITER -- AND BEYOND

¶8. McKee went on to opine that "KSTAR is poised to be the most fruitful experiment in the world in several years to further advance both the performance of fusion plasmas and our scientific understanding of basic fusion plasma processes....The KSTAR experiment will be a crucial experiment for investigating the physics of 'long-pulse, high performance' fusion plasmas. One of the major uncertainties in fusion looking forward to ITER and beyond is how the high-temperature plasma and the Tokamak vessel interact over long time periods (tens of seconds to minutes) while sustaining high-temperature, high-pressure plasmas." Experience shows that high performance can be maintained for relatively short periods -- several seconds -- but sustaining for longer pulses requires complex feedback control of plasma instabilities and the avoidance of deleterious plasma-wall interactions.

¶9. McKee concluded that "KSTAR will seek to maintain high "normalized" performance that should provide very useful scientific information and techniques for developing high performance plasmas

for ITER as well as for extrapolating beyond ITER to fusion reactors. Thus it will continue to be a very relevant and pioneering experiment even during the operation of ITER."

U.S. SCIENTISTS DEEPLY INVOLVED

¶10. The U.S. Department Energy and numerous U.S. research institutions have been deeply involved in the design and construction of KSTAR. With two major fusion centers in the U.S. (Princeton Plasma Physics Laboratory in New Jersey and General Atomic Company in San Diego) taking the lead, this collaboration has included scientists from the University of Wisconsin, the University of California at Davis, Columbia University, and Oak Ridge National Laboratory, among others. Dr. McKee provided details:

"The U.S. and Korea are engaged in numerous active collaborations centered around the KSTAR experiment in the areas of plasma control, radio-frequency and microwave-based heating systems, plasma stability, and imaging and profile diagnostics. The U.S. Department of Energy is providing funding for numerous design studies and control system development for the KSTAR experiment. These collaborations take place with U.S. National Laboratories, companies, and universities...."

¶11. To further emphasize the long-term nature of the U.S.-Korea collaboration, Dr. McKee remarked that the KSTAR experiment design is based in part on a Tokamak design (Tokamak Physics Experiment, or TPX) that was developed in the U.S., with the leadership of

Princeton Plasma Physics Laboratory. A DOE official later commented to ESTH that the TPX design was not built in the United States due to a lack of funding, so it was gratifying to see that the design proved so useful in the construction of KSTAR.

COMMENT

¶12. Several speakers at the September 14 ceremony, including ITER Secretary General-designate Kaname Ikeda, described KSTAR as

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allowing Korea to assume a leading role in international fusion research. Hopes are high that KSTAR will contribute to hastening the day when electricity generation using fusion is shown to be both feasible and cost-effective. Meanwhile, KSTAR's completion testifies both to the advances of Korean science over the past four decades, and to the continuing vigor and fruitfulness of U.S.-Korean scientific collaboration.

VERSHBOW